UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH ADMINISTRATION
Bureau of Human Nutrition and Home Economics

EXPERIMENTAL PROCEDURE FOR CONDUCTING TASTE AND SMELL TESTS.

A series of tests adapted from data reported in the literature proposing to measure acuity of taste and smell are being used experimentally in the Bureau of Human Nutrition and Home Economics. These tests are given to all prospective food judges.

At present, there is no evidence that a direct relationship exists between sensitivity to the taste of chemically pure solutions and ability to detect flavors in food products. As a result, people with high as well as average or low thresholds should be included in judging panels until data from a number of laboratories may make it possible to determine what relationship exists.

The value of these tests as a training tool for food judging also needs to be determined.

Using solutions of chemically pure substances, tests are made to find the lowest concentration at which an individual can identify each primary taste (sour, bitter, salt, and sweet); the ability of an individual to detect differences in concentration of a single primary taste; and his ability to distinguish between solutions containing different primary tastes. The test used for olfactory acuity does not have the fine discriminatory power of the taste tests and is only proposed as a means of selecting those individuals who have lost their sense of smell to a considerable extent.

Before testing a group by the procedure described below individuals who are susceptible to mouth infections, sinus infections, or frequent colds, or who are allergic to a large number of foodstuffs are eliminated. Also, no one is tested while he has a cold or transient infection. The remaining individuals are tested for sensitivity of smell and taste.

Smell Tests

Fourteen substances are used to test for acuity of smell. Six substances which have been shown by other workers to be satisfactory for detecting below average olfactory sensitivity or tactile sensitivity in the nose, and eight odorous substances which are important in general food flavor or in dehydrated foods are used. The first group includes coffee, menthol, ammonia, benzaldehyde (oil of bitter almond) citral (oil of lemon), and turpentine, and the latter group includes onion, vanilla, cloves, vinegar, rancid butter, hydrogen sulfide, strong cabbage, and hay. Hay is used as several people have detected an objectional "hay" odor in samples of dehydrated soups and vegetables.

The test materials are placed in small test tubes, covered with cotton, and the tubes stoppered. The tubes are wrapped so that the substances cannot be identified by sight. Each individual records the odor of the substance in each tube as judged by sniffing. The record card used is shown in Figure 1. The ability to name a substance correctly is influenced largely by past experience and if an individual is able to describe an odor rather than name it his answer is judged correct.

Taste Tests

It is best to test the sense of taste at least 2 hours after eating. The person being tested should be allowed to become completely familiar with the taste of the distilled water used in making up the solutions and with the taste of salt, sweet, bitter, and sour. The mouth should be washed with distilled water after each taste. When an individual is ready for the tests an attendant measures out five milliliters of each solution into a series of beakers which are presented in the different tests as described below. It is not necessary to swallow the solution, but the solution should be allowed to touch the back part and sides of the tongue. It has been found that the judges do not tire nearly so soon if the solution is discarded rather than swallowed after each taste. The number of judgments that may be made at one time without fatigue has not been determined but we have found it satisfactory to administer Tests I and II at one sitting. Test III is given at another time. Tests I and II require approximately one hour and Test III, 15 to 20 minutes. All prospective judges should be given all three tests at least twice.

The concentration of all solutions used in this laboratory are listed in Table 1. The range in concentration is determined by the taste sensitivities of the group to be tested. The thresholds of taste presented in Table II and those found in the literature may be used as guides in addition to preliminary tests on the personnel involved. One or two solutions below the lowest threshold and above the highest threshold of the group should be included in each series.

The instruction and record card used are shown in Figures 2 and 3.

Test I. To find the lowest concentration at which an individual can identify a primary taste, that is, his threshold, he is presented with a series of solutions of a single substance in order of increasing concentration. Each person is told he is being tested for sensitivity of taste to one of the four known primary tastes--salt, sweet, sour, and bitter--but he is given no clue as to the order in which the substances are offered. The solutions are tasted, starting with the lowest concentration, until the primary taste represented can be identified with certainty. It has been found most satisfactory to have an examiner record the individual's reaction to each solution rather than let the subject keep the record himself. It is quite common for an individual to have a reaction of bitter or sour below the concentration at which he can taste the substance contained in the solutions. This test is performed with five series of solutions, one taste, sour, being repeated in order that the tasters will not be aided too greatly by the process of elimination. When the complete test is given to an individual for the second time bitter, salt, or sweet is repeated rather than sour.

Test II. To test the ability of an individual to detect small differences in concentration, he is presented with solutions No. 1 to 8 (Table 1) of one series at a time. The beakers are shuffled and the individual is instructed to arrange the solutions in the order of increasing concentration. Since individuals whose thresholds fall in the high range (see Table 2) cannot detect the substance in the low range, they are given the 4 concentrations immediately above and the 4 immediately below his threshold. Discriminatory ability is tested in either case.

Test III. The taster is asked to identify nineteen solutions chosen from four of the series. Four solutions from each of the series of sodium chloride, sucrose, hydrochloric acid, and quinine, two samples of distilled water and a solution chosen at random are used. Concentrations are chosen in the vicinity of the individual's threshold using in each series one solution just below the determined threshold.

In all three tests the solutions are presented to the individual in 50 ml. beakers with no identifying marks. The beakers may be numbered by the use of small gummed labels or adhesive tape written lightly with pencil and which are placed on the bottom of the beaker and covered with paraffin. When the beakers are to be used by another individual they are washed in soap and hot water, rinsed thoroughly and dried with a clean, lintless towel. It is most satisfactory to have enough beakers available so that there is one for every solution to be tasted. All solutions should be made up with distilled water obtained from all-glass still as this water has been found to be as nearly tasteless as possible. A definite flavor can be detected by most judges in water from a metal still or from one containing rubber connections. The temperature of all solutions and of the distilled water used for rinsing the mouth should be kept at some one temperature chosen between 20 and 30° C. and this temperature kept constant throughout the course of the experiment. Twenty-seven degrees Centigrade was chosen in this laboratory as it was the temperature most easily maintained.

Test I, attempts to measure thresholds for the primary tastes. In Table 2 are given the low, medium and high ranges of taste thresholds which have been found in testing forty prospective judges.

Test II, attempts to measure discriminatory ability. The use of the rank correlation coefficient is suggested for scoring the arrangements.

$$\rho = 1 - \frac{6\Sigma(x-y)^2}{n\,(n^2-1)}$$

where x = correct rank of each solution

y = actual rank of solution

n = number of ranks

The solutions used should be numbered from one to eight for the purposes of this calculation. When n = 8, $\frac{6}{n(n^2-1)} = 0.0119$. The sum of $(x-y)^2$ need only be calculated for each series of placements multiplied by 0.0119 and subtracted from unity to give ρ. The rank correlation is of service as a quick method of gauging relations between variates which are not normally distributed and when the number of observations is small. By the use of this procedure we have tested individuals whose scores range from $\rho = 0$ to $\rho = 1$. As explained in the experimental procedure all individuals should be given exactly the same series of solutions to give comparable results. Individuals whose threshold is so high that a different series of solutions must be used can of course be rated by this technique but the possible error involved should be kept in mind.

Test III serves the double purpose of checking the threshold as determined in Test I and testing a person's ability to distinguish the primary tastes. Most individuals will be able to distinguish solutions at or above his threshold with accuracy and below this point will taste nothing.

The attached bibliography includes references on which these tests are based.

Table 1

Molar Concentration of Chemicals Used in Each Series of Taste Test

Solution Number	Sodium Chloride M.W. 58,45	Sucrose M.W. 342.17	Quinine Sulfate M.W. 782.51	Hydrochloric Acid * M.W. 36.36	Lactic Acid M.W. 90.08
	moles/l.	moles/l.	moles/l.	moles/l.	moles/l.
0	.0000	.0000	.0000	.0000	.0000
1	.001	.0005	.0000005	.00005	.00005
2	.0025	.001	.00000075	.0001	.0001
3	.005	.005	.000001	.00025	.00025
4	.0075	.0075	.000002	.0005	.0005
5	.01	.01	.000003	.00075	.00075
6	.015	.015	.000004	.001	.001
7	.02	.02	.000005	.00125-	.00125
8	.025	.025	.000006	.0015	.0015
9	.03	.03	.000007	.002	.002
10	.035	.035	.000008	.0025	.0025
11	.04	.04	.00001	.005	.005
12	.05	.05	.000025	.0075	.0075
13	.075	.075	.00005	.010	.01
14	.1	.1	.000075	.015	.015
15	.15	.15	.0001	.02	.02

*Molarities only approximate. Twelve grams of concentrated hydrochloric acid (sp. gr. 1.18 - 1.19) were diluted to one liter to give a stock solution slightly greater than .1N. Dilutions from the stock solution were made carefully.

Table 2

Thresholds of Taste *

	Low Range	Medium Range	High Range
	Moles/l.	Moles/l,	Moles/l.
Sodium Chloride	0.0025-0.005	0.0075-0.02	0.025-0.1
Sucrose	0.0005-0.005	0.0075-0.02	0.025-0.15
Quinine Sulfate	0.0000005-0.000001	0.000002-0.000006	0.000007-0.00005
Hydrochloric Acid	0.00005-0.00025	0.0005-0.001	0.00125-0.01

* The ranges given above were established in the following manner on the basis of data obtained in our laboratory: The concentration of each solution was plotted in the form of a bar graph against the number of individuals whose threshold fell at that concentration. A break in the curve was observed at the concentration given as the limits of the medium range. Ten to twelve individuals from a total of forty fell outside the medium range with seven to eight of these cases falling in the high range. It is possible that slight differences in technique could shift these breaking points up or down the scale of concentrations one or two steps and it is recommended that the data in each laboratory be plotted in a similar manner.

Figure 1
RECORD CARD FOR TASTE TEST OF PURE SOLUTIONS

Name _____ Date _____ Time _____ How long since eating? _____ Do you smoke? ___

Are you susceptible to head colds? _____ Do you have any special food likes or dislikes? _____

Have you a "sweet tooth"? _____ Do you salt food lightly, moderately, or heavily? _____

Do you like grapefruit, and if so, with or without sugar? _____

Which do you prefer, bitter or sweet chocolate? _____

Test I. Arrange in order of concentration. Record taste reaction to each solution.

Code:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Series A																
Series B																
Series C																
Series D																
Series E																

Test II. Shuffled series. Record the order of placement.

Series A _____

Series B _____

Series C _____

Series D _____

Series E _____

Test III. Mixed series. Redord number and corresponding taste reaction.

Figure 2

MEASURING SENSITIVITY OF TASTE TO PURE SOLUTIONS

Instruction Card

Solutions to be tasted: Salt - Bitter - Sweet - Sour

Directions: Rinse the mouth well with distilled water. Taste each solution as directed below, being certain that the solution reaches the back of the mouth. Spit it out if desired. Rinse mouth thoroughly after tasting any strong solutions.

The examiner will give you more solution if needed.

Test I. Taste each solution from left to right and tell the examiner your taste reaction to each solution. Each series will consist of only one primary taste.

Test II. The solutions in each series have been shuffled. Arrange solutions in order of increasing concentration.

Test III. Taste each solution in a mixed series containing all four primary tastes. Record your taste reaction to each solution.

Figure 3
RECORD CARD FOR SMELL TEST

Name: _____
Date: _____

No.	INTENSITY OF ODOR					DESIRABILITY					
	Odorless	Faint	Mild	Moderate	Strong	Very Pleasant	Pleasant	Indifferent	Unpleasant	Very Unpleasant	Name odor if possible or describe
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											

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